TransAnal Minimally Invasive Surgery (TAMIS): A Clinical Spotlight Review

Teresa deBeche-Adams, Imran Hassan, and the SAGES Guidelines Committee

Preamble

The following clinical spotlight review regarding Transanal Minimally Invasive Surgery (TAMIS) is intended for physicians who manage and treat rectal pathology. It is meant to critically review this technique and the available evidence supporting its safety and efficacy. Based on the level of evidence, recommendations may or may not be given for its use in clinical practice.

Disclaimer

Guidelines for clinical practice and spotlight reviews are intended to indicate preferable approaches to medical problems as established by experts in the field. These recommendations will be based on existing data or a consensus of expert opinion when little or no data are available. Spotlight reviews are applicable to all physicians who address the clinical problem(s) without regard to specialty training or interests, and are intended to convey recommendations based on a focused topic; within the defined scope of the review, they indicate the preferable, but not necessarily the only acceptable approaches due to the complexity of the healthcare environment. Guidelines and recommendations are intended to be flexible. Given the wide range of specifics in any healthcare problem, the surgeon must always choose the course best suited to the individual patient and the variables in existence at the moment of decision. Guidelines, spotlight reviews, and recommendations are developed under the auspices of the Society of American Gastrointestinal Endoscopic Surgeons and its various committees, and approved by the Board of Governors. Each clinical spotlight review has been systematically researched, reviewed and revised by the guidelines committee, and, when appropriate, reviewed by an appropriate multidisciplinary team. The recommendations are therefore considered valid at the time of production based on the data available.

Literature review

A systematic literature search was performed using PubMed for Transanal Minimally Invasive Surgery (TAMIS). The literature was reviewed from September 1, 2010 through May 31, 2016.

This is the author's manuscript of the article published in final edited form as:
deBeche-Adams, T., Hassan, I., Haggerty, S., & Stefanidis, D. (2017). Transanal Minimally Invasive Surgery (TAMIS): a clinical spotlight review. Surgical endoscopy, 31(10), 3791. https://doi.org/10.1007/s00464-017-5636-4

Both the quality of the evidence and the strength of the recommendation for each of the guidelines were assessed according to the GRADE system. This uses a 4-tiered system for denoting the quality of evidence (very low (+), low (+ +), moderate (+ + +), or high (+ + + +)) and a 2-tiered system for strength of recommendation (weak, or strong).[1,2]

I. Introduction

Transanal minimally invasive surgery (TAMIS) is a technique that was originally devised as a hybrid between Transanal Endoscopic Microsurgery (TEM) and single-site laparoscopy for resection of rectal lesions. It was developed out of the need for a practical alternative to TEM that was both affordable and technically feasible without specialized equipment. TEM, introduced over 30 years ago by Dr. Gerhard Buess,[3-8] has demonstrated to be superior to standard transanal excision for treating benign and malignant rectal lesions, most notably due to its ability to perform high-quality resections with decreased incidence of fragmentation.[9,10] The benefit is likely due to the quality optics, instruments, and specialized insufflation system. Despite its feasibility and efficacy, the widespread implementation of TEM has been prevented by several barriers, mostly attributable to its steep learning curve and expensive equipment.[11-13] Because of this, the optimal method for removal of lesions of the mid and upper rectum remains controversial. Patients are referred to specialized centers performing TEM or are subjected to more radical surgery such as a low anterior resection (LAR) or abdominoperineal resection (APR). First described in 2010,[14] TAMIS is based on a platform that is readily available in most hospitals, bringing access for more proximal rectal lesions to any minimally invasive surgeon with a clear knowledge and understanding of rectal pathology, anatomy, and surgery. It is categorized by the use of a single-site port transanally in combination with ordinary laparoscopic instruments, a laparoscopic camera lens, and a standard laparoscopic CO2 insufflator for the purpose of performing endoluminal rectal surgery.

Literature suggests that the TEM approach allows for more intact, non-fragmented specimens (100% vs. 63%), negative resection margins (98% vs. 78%), and lower recurrence rates (8% vs. 24%) than standard transanal excision.[10] Similar results have been presented with TAMIS, with a 4% fragmentation rate, 6% microscopic margin positivity and a 2% recurrence rate.[15] There are several data comparing TEM to standard transanal excision and to radical intra-abdominal approaches but a paucity of publications comparing TEM and TAMIS. An ex vivo study grading surgeons not trained in transanal techniques showed similar scores for completing an adequate dissection using both TEM and TAMIS equipment.[16]

Some of the advantages of TAMIS over TEM include rapid set-up time, 360 degrees vs. 220 degrees of visibility within the rectal lumen, the ability to universally adapt any existing laparoscopic instruments in the hospital, and the ease of lithotomy positioning within the operating theatre.[14,17-24] The initial description of the procedure reported a set-up time as rapid as 2 minutes.[14] This greatly reduces the total operative time when compared to TEM, which can have set up times as long as 30-45 minutes if

the lesion is in an inconvenient position. The cost of the single-use ports used for TAMIS is nearly equivalent to the cost of the specialized disposable CO_2 tubing required for each TEM case.[14,18] Similar to TEM, [14,25-27] TAMIS also results in minimal anal sphincter dysfunction.[68,69]

II. Statement of focus

The intent of this clinical spotlight review is to critically review literature related to TAMIS, including the indications, setup and equipment, technical aspects, and clinical outcomes of the procedure.

III. Pre-Operative Workup and Patient Selection for Rectal Masses

A. Pre-Operative Workup

If a rectal lesion is identified on digital rectal exam, a full colonoscopy should be performed to rule out any synchronous lesions and to biopsy the rectal mass. A detailed physical examination should be documented including digital rectal exam and rigid proctoscopy noting the size, distance from the anal verge and anorectal junction, and positional orientation of the lesion. Careful attention should be paid to whether the tumor is soft or firm, mobile or fixed. If the biopsy returns as a malignant lesion, further workup for accurate staging should be performed using rectal MRI or Endorectal ultrasound (EUS). Which modality to use depends on institutional availability and expertise, but using one or both is acceptable.[28,29] CT of the chest, abdomen, and pelvis are also ordered to rule out metastatic disease along with routine laboratory investigations, including carcinoembryonic antigen (CEA) levels, and molecular tumor markers according to National Comprehensive Cancer Network (NCCN) Guidelines.[30]

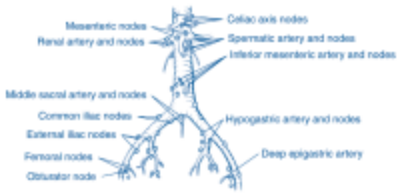
B. Patient Selection

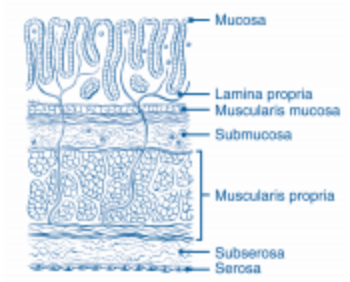
The indications for TAMIS are similar to TEM and standard transanal resection for benign and malignant lesions determined by EUS or MRI.[31-33] For malignant masses, TAMIS is generally appropriate for patients with early rectal cancer, which is defined as invasive adenocarcinoma confined to the submucosal layer, or T1.[34]

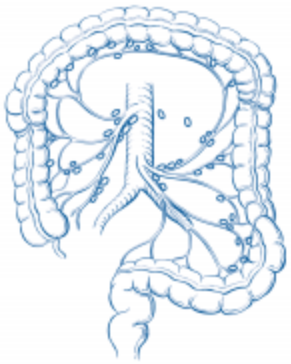
American Joint Committee on Cancer

Colon and Rectum Cancer Staging

7th EDITION







Definitions

Primary Tumor (T)

- **TX** Primary tumor cannot be assessed
- **T0** No evidence of primary tumor
- **Tis** Carcinoma in situ: intraepithelial or invasion of lamina propria[1]
- **T1** Tumor invades submucosa
- **T2** Tumor invades muscularis propria
- **T3** Tumor invades through the muscularis propria into pericolorectal tissues
- **T4a** Tumor penetrates to the surface of the visceral peritoneum[2]
- **T4b** Tumor directly invades or is adherent to other organs or structures[2,3]

Regional Lymph Nodes (N)[4]

- **NX** Regional lymph nodes cannot be assessed
- **N0** No regional lymph node metastasis
- **N1** Metastasis in 1–3 regional lymph nodes
- **N1a** Metastasis in one regional lymph node
- **N1b** Metastasis in 2–3 regional lymph nodes
- **N1c** Tumor deposit(s) in the subserosa, mesentery, or nonperitonealized pericolic or perirectal tissues without regional nodal metastasis
- **N2** Metastasis in 4 or more regional lymph nodes
- **N2a** Metastasis in 4–6 regional lymph nodes
- **N2b** Metastasis in 7 or more regional lymph nodes

Distant Metastasis (M)

- **M0** No distant metastasis
- **M1** Distant metastasis
- **M1a** Metastasis confined to one organ or site (for example, liver, lung, ovary, nonregional node)
- **M1b** Metastases in more than one organ/site or the peritoneum

ANATOMIC STAGE/PROGNOSTIC GROUPS

Stage	T	N	M	Dukes*	MAC*
0	Tis	N0	M0	–	–
I	T1	N0	M0	A	A
	T2	N0	M0	A	B1
IIA	T3	N0	M0	B	B2
IIB	T4a	N0	M0	B	B2
IIC	T4b	N0	M0	B	B3
IIIA	T1–T2	N1/N1c	M0	C	C1
	T1	N2a	M0	C	C1
IIIB	T3–T4a	N1/N1c	M0	C	C2
	T2–T3	N2a	M0	C	C1/C2
	T1–T2	N2b	M0	C	C1
IIIC	T4a	N2a	M0	C	C2
	T3–T4a	N2b	M0	C	C2
	T4b	N1–N2	M0	C	C3
IVA	Any T	Any N	M1a	–	–
IVB	Any T	Any N	M1b	–	–

NOTE: cTNM is the clinical classification, pTNM is the pathologic classification. The y prefix is used for those cancers that are classified after neoadjuvant pretreatment (for example, ypTNM). Patients who have a complete pathologic response are ypT0N0cM0 that may be similar to Stage Group 0 or I. The r prefix is to be used for those cancers that have recurred after a disease-free interval (rTNM).
* Dukes B is a composite of better (T3 N0 M0) and worse (T4 N0 M0) prognostic groups, as is Dukes C (any TN1 M0 and Any T N2 M0). MAC is the modified Astler-Coller classification.

Financial support for AJCC 7th Edition Staging Posters provided by the American Cancer Society

Notes

[1] Tis includes cancer cells confined within the glandular basement membrane (intraepithelial) or mucosal lamina propria (intramucosal) with no extension through the muscularis mucosae into the submucosa.

[2] Direct invasion in T4 includes invasion of other organs or other segments of the colorectum as a result of direct extension through the serosa, as confirmed on microscopic examination (for example, invasion of the sigmoid colon by a carcinoma of the cecum) or, for cancers in a retroperitoneal or subperitoneal location, direct invasion of other organs or structures by virtue of extension beyond the muscularis propria (that is, a tumor on the posterior wall of the descending colon invading the left kidney or lateral abdominal wall; or a mid or distal rectal cancer with invasion of prostate, seminal vesicles, cervix, or vagina).

[3] Tumor that is adherent to other organs or structures, grossly, is classified cT4b. However, if no tumor is present in the adhesion, microscopically, the classification should be pT1–4a depending on the anatomical depth of wall invasion. The V and L classifications should be used to identify the presence or absence of vascular or lymphatic invasion, whereas the PN site-specific factor should be used for perineural invasion.

[4] A satellite peritumoral nodule in the pericolorectal adipose tissue of a primary carcinoma without histologic evidence of residual lymph node in the nodule may represent discontinuous spread, venous invasion with extravascular spread (V1/V2), or a totally replaced lymph node (N1/2). Replaced nodes should be counted separately as positive nodes in the N category, whereas discontinuous spread or venous invasion should be classified and counted in the Site-Specific Factor category Tumor Deposits (TD).

This can be further categorized into low-risk T1 adenocarcinomas of the rectum, which are characterized as small (< 4 cm), well differentiated tumors without lymphatic, vascular or perineural involvement.[35] For patients with poor histologic features (lymphovascular or perineural invasion, poor differentiation, tumor budding), discussion at a multi-disciplinary tumor board should ensue to reach a consensus on subsequent treatment. T1 cancers with deeper submucosal invasion (sm2 or sm3) as determined by the Kikuchi classification of sessile lesions may confer metastatic potential to lymph nodes and should essentially be treated as a T2 lesion.[36,37]

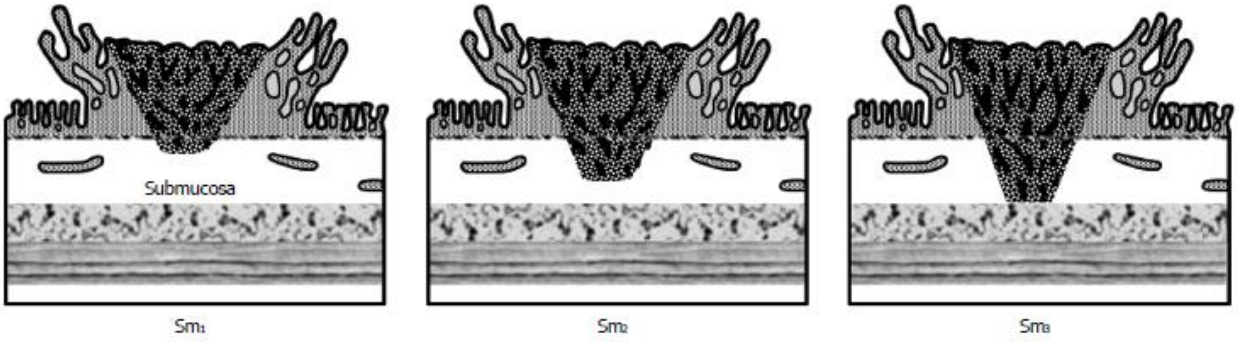


Image 1 Depth of submucosal invasion: submucosa divided into thirds according to Kikuchi classification

For indeterminate T1 versus T2 lesions with no evidence of nodal disease, a TAMIS resection can serve as definitive biopsy confirming T stage and guiding further treatment with the final pathology. These patients should be counseled preoperatively that if the pathology returns as a T1 lesion with favorable pathologic characteristics, they would have undergone a curative-intent surgery with no need for further intervention. If the pathology returns as T1 with adverse pathologic features (including deeper submucosal invasion) or a T2 lesion, they may still need a formal radical resection (in the form of an LAR or APR) or adjuvant chemotherapy and radiation. Borschitz and colleagues[38] reported a 12% local recurrence after immediate reoperation vs 35% recurrence for those who underwent TEM alone for T2 cancers. Several other reports determined comparable oncologic outcomes for immediate reoperation after local excision compared to primary radical resection.[39,40] In a study by Dudek in 2008, [41] the most favorable outcomes were in those pT2 lesions resected with negative margins that went on to receive adjuvant radiotherapy; all 12 of the patients were disease-free after a median follow-up of 3 years. Conversely, patients with uT2 lesions may be down staged with preoperative chemotherapy and radiation prior to TAMIS resection. In a few studies this has led to promising results,[42,43] including a number of patients that developed complete pathologic response.[44,45] The most impressive results have come from Habr-Gama and Perez, with up to 44% complete response utilizing their protocol for neoadjuvant chemo-radiotherapy.[46] This unquestionably needs longer term follow-up before it can become standard protocol.

Advanced lesions (T3) can be considered for TAMIS resection when patients are deemed medically unfit to have a more radical surgery. Patients found to have nodal disease or distant metastases should be evaluated by a multidisciplinary tumor board where available and considered for chemotherapy and

radiation prior to surgical resection. The indications for TAMIS can also be broadened to include local excision of clinical T0 (cT0) lesions in patients with locally advanced rectal cancer after neoadjuvant therapy for the purpose of confirming mural complete pathologic response (cPR) or ypT0.[47-49] This approach is acceptable given that the risk of occult node positivity for ypT0 lesions is predictably low, at 3-6%.[50-52] The discussion with the patient should highlight the benefits and risks of preservation of rectal function and avoiding functional consequences of a pelvic dissection with the understanding that they still need close follow-up postoperatively.

Though there are limited data evaluating the effectiveness of TAMIS for resection of carcinoid tumors, it seems a likely alternative for removing small rectal carcinoids either primarily or after incomplete endoscopic removal.[72,80] Several studies from the TEM data show that these are usually smaller lesions and less challenging than rectal adenocarcinomas.[73] These authors report no positive margins in their final surgical specimens and no local recurrence.[71-76] In the TAMIS data, similar results are noted in recurrence rates after TAMIS excision for rectal carcinoids, with no recurrences at 9.8 months of follow up.[27]

IV. Operative Technique

A. Surgical Preparation

Standard perioperative protocols for colorectal surgery should be followed, including perioperative antibiotics, beta blockers and DVT prophylaxis. A bowel preparation is needed but the type can be left up to the surgeon's preference. [53] Some may prefer to have their patients perform a full mechanical bowel preparation,[54,55] but a flexible sigmoidoscopy preparation (dose of oral laxative and 2 enemas) is more than adequate for visualization in most patients. The complication of colonic gas explosion has not been encountered, most likely due to the fact that CO_2 is used for insufflation and that the smoke, and therefore methane gas, is vented during the procedure.

Lithotomy position can be used in all patients regardless of the lesion location. This expedites set up time in the operating room and is preferred by most anesthesiologists. Alternative positions such as prone jack-knife or lateral decubitus have also been described. The prone jack-knife position can be considered for anterior based lesions, although the disadvantage of having to reposition the patient in the case of peritoneal entry has to be considered.[53-56] Candy cane or Allen stirrups may be used based on their availability. If there is any question that abdominal access may be required such as anticipated peritoneal entry for anterior proximal lesions, Allen stirrups are preferred so that the legs may be repositioned for the abdominal portion of the procedure. Patients should be low on the table to enable transanal access, and the stirrups should be high enough to prevent encroachment on the surgeon's working space. Trendelenburg position can be added if needed. A video monitor placed over the abdomen between the patient's legs provides the most ergonomic position for the surgeon and

assistant. Patients can then be prepped and draped in the normal fashion. If peritoneal entry is anticipated, the abdomen can be prepped preemptively as well.[15]

B. Set up and equipment

In the US, there are currently two FDA approved devices for transanal access for the TAMIS procedure--the GelPOINT Path (Applied Medical, Rancho Santa Margarita, CA) and the SILS™ Port (Covidien, Mansfield, MA). Both are easily placed transanally and allow insufflation through a separate channel.

The GelPOINT Path also has a channel for smoke evacuation to maintain clear visualization throughout the procedure. The remaining equipment is standard instrumentation found in the operating room, usually in a rectal tray and a laparoscopic cholecystectomy tray. Pneumorectum is achieved using a typical laparoscopic tower with CO_2 for insufflation. Initial pressure settings should be between 8-18 mmHg and can be increased if there is difficulty maintaining distention of the rectum for visualization. Recently the use of the AirSeal® insufflator has been described to create and maintain pneumorectum.[57] This provides continuous high flow insufflation, pressure sensing and smoke evacuation and may prove to be a promising addition to the equipment given that the rectum presents such a confined environment. General anesthesia with muscle paralysis is recommended to avoid collapse of the rectal wall which can occur with diaphragmatic breathing. TAMIS has been described using spinal anesthetic successfully as well.[27] Routine placement of a Foley catheter can be considered.[55]

A 30 or 45-degree angled laparoscope,[55,56] ideally with inline or right angled optical cables, is preferred during dissection over 0-degree scopes. Bariatric length laparoscopes can also be used to prevent instrument conflicts. Alternatively, a colonoscope or flexible tipped scopes have also been described for visualization.[53,54] Maryland graspers, or similar, may be used for retraction. Monopolar electrosurgery is generally adequate for dissection. This can be connected to a standard suction irrigator to facilitate suctioning of fluid or smoke during the procedure. More advanced bipolar devices can also be used but will add expense to the procedure. These are excessive for a submucosal dissection but may be better suited for a full-thickness resection.

Closure of the defect, when necessary, is accomplished with simple laparoscopic suturing techniques using standard needle drivers or with more advanced laparoscopic closure devices based on the surgeon's preference. These devices may be more expensive but may decrease the operative time.

C. Technical considerations

Standard principles used in transanal resection or TEM resection of lesions should be followed for a TAMIS resection as well. It is recommended that the lesion be marked around its circumference to ensure an adequate margin prior to beginning the dissection. Benign lesions such as adenomas may be excised in the submucosal plane with negative margins. Because these are not full-thickness defects, they do not necessarily need to be closed. For malignant lesions, a 1 cm margin should be marked out around the entire mass prior to a full-thickness resection.[38] It is of utmost importance to remain perpendicular to the tumor so as not to compromise the deep margin.

For posterior tumors, a small cuff of perirectal fat can be excised with the specimen to ensure full thickness excision and allow pathologic evaluation of lymph nodes in the immediate area.[58] Care must be taken not to disrupt the mesorectal envelope so that if unfavorable pathology is discovered unexpectedly, a rescue TME can still be performed without violating oncologic principles. CO_2 insufflation can provide a natural 'pneumo-dissection' which helps expose the planes of dissection.[14,54]

Closure of the defect is one of the more time-consuming portions of the procedure. Submucosal resections can be left open. Full thickness defects can technically be left open as they are extra-peritoneal;[53] however, it is generally recommended to close all defects so that if a peritoneal entry does occur, the necessary skills to close the defect have been practiced.[56] Defects are closed transversely so as not to narrow the lumen of the rectum[8] and can be done with a running stitch or with multiple figure-of-eight stitches. It is more difficult to tie intracorporal knots within the limited confines of the rectal lumen. To overcome this, intraluminal knot-tying can be accomplished with the use of a knot-pusher or laparoscopic suture clips. Laparoscopic suturing devices also speed up this process, decreasing operative times. For patients with prior radiation, a higher incidence of wound dehiscence is sometimes noted.[59]

Evidence shows lesions located anteriorly in the middle or upper third of the rectum carry a higher risk of peritoneal entry, likely owing to a lower peritoneal reflection on the anterior and lateral surfaces of the rectum.[62] If intraperitoneal entry does take place, the patient should be placed in steep Trendelenburg position to allow the abdominal contents to fall out of the pelvis. Though many peritoneal entries can be closed via the TAMIS port, it can sometimes be difficult to maintain pneumorectum and adequate visualization with a defect into the peritoneal cavity. In this instance, converting to a laparoscopic assisted approach to aid in closure of the defect should not be delayed.[56,60,61] Some authors recommend placing patients in the prone position if peritoneal entry is likely, where the pressure on the abdomen limits the amount of insufflation that can traverse into the peritoneal cavity.[81] A Gastrografin enema can be considered prior to discharge to ensure that there is not a leak after repair.

For very distal lesions at or just above the dentate line, a hybrid approach with standard transanal and TAMIS equipment can facilitate resection.[77] The distal margin is incised using standard transanal retractors from the hemorrhoidectomy tray and electrosugery. The TAMIS port can then be inserted to use for the remainder of the proximal dissection. This allows for better visualization of the proximal extent of the tumor and less fragmentation of the specimen. Closing a distal defect is easier, as a single stitch can be placed on the proximal edge in the midline of the excision site and used to reapproximate to the distal edge via standard transanal approach.[62]

V. Postoperative Care and Follow-up

TAMIS is generally viewed as an outpatient procedure and most patients are discharged on the day of surgery. Depending on comorbidities, the option to admit for 23-hour observation with discharge on the first post-operative day is also reasonable. Diets can be advanced as tolerated without restrictions. If a full-thickness resection was undertaken or intra-peritoneal entry occurred, SCIP protocol requires antibiotic coverage for 24 hours postoperatively. Those that use pre-operative ertapenem have no need for repeat dosing. Patients can be transitioned to oral antibiotics with anaerobic and gram negative coverage for a period of seven days if there is concern for local infection.

Standard postoperative follow-up is generally performed at two and six weeks. Rigid proctoscopy is part of the clinical exam to assess healing. Patients with malignant lesions who underwent a satisfactory TAMIS excision are followed according to National Comprehensive Cancer Network guidelines depending on final pathology. For patients with excised specimens that reveal more advanced disease or histologically unfavorable features, discussion at a multidisciplinary tumor board should ensue. The options for further treatment may include standard oncologic resection or postoperative chemotherapy and radiation.[30]

VI. Clinical outcomes

In a systematic review of the literature that was published in 2014, thirty-three retrospective studies and case reports representing 390 TAMIS procedures published between 2009 and 2014 were reviewed.[62] The average size of the lesions resected was 3.1 cm (range 0.8-4.75 cm) and the mean distance from the anal verge was 7.6 cm (range 3-15 cm). Margin status was described in 25 out of the 33 publications (n=275 patients) and 12 specimens were reported as having positive margins (12/275, 4.36%). Similarly specimen fragmentation was reported in 10 of 22 publications (n=97 patients) and was approximately 4%. Being a relatively new technique, there is limited follow-up data. The recurrence rate after excision of benign and malignant lesions was reported in 16 publications (n=259) and was 2.7% (7/259) with a 7.1 month follow-up. Of all the published studies in this review, only 8 had 15 or more patients.

One of the largest published series in this review was by Albert and Atallah and included 50 patients (25 benign neoplasms, 23 malignant lesions, and 2 neuroendocrine tumors). In this study with a 20-month follow-up, the overall locoregional recurrence rate was 4.3%. Positive margins were demonstrated in 6% of the specimens.[15] A more recent series by Keller and Haas outlines 75 patients (59 benign, 17 malignant lesions) with a median follow-up of 39.5 months. Positive margins were equivalent in 6.6% of patients and only one patient developed recurrence at the conclusion of the review period. Three patients had intraperitoneal entry and all were able to be closed transanally.[77]

Postoperative complications associated with TAMIS include general complications associated with surgery as well as specific complications related to anorectal procedures. General morbidity include infectious (fever, urinary tract infections, *C. difficile* colitis) and cardiopulmonary (atrial fibrillation, COPD exacerbation) complications. Procedure specific complications include bleeding, urinary retention, extraperitoneal wound dehiscence, rectal stenosis and transient fecal incontinence.[62] Peritoneal entry is a known complication of this technique and is more likely to occur with lesions that are anterior and located in the proximal one-third of the rectum. Based on extensive TEM experience, there are no data to suggest that full-thickness excision of rectal tumors and peritoneal entry is associated with postoperative complications.[78,79] Rectovaginal fistula has also been described and should be cautiously considered in female patients.[77]

VII. Additional Applications

The TAMIS platform continues to evolve, mostly because it provides easy access to the rectum and pelvis that allows it to be used for various additional applications. TAMIS has now been successfully performed with a variety of ports including other commercially available single-site ports[60,63] and even a customized glove-port.[64] Internationally, the further ports available are the KeyPort Flex (Richard Wolf, Knittlingen, Germany), the SSL (Single-Site Laparoscopic access system, Ethicon Endo-Surgery, Cincinnati, OH), and the Endorec® (Aspide Médical, LaTalaudière, France). With improved transanal visibility and exposure, TAMIS has been described for repair of rectourethral fistula, ligation of distal rectal hemorrhage, and removal of rectal foreign body.[65] It is currently being effectively used as a new access channel for NOTES procedures, including transanal total mesorectal excision (taTME).[66,67] This modality is rapidly evolving and will be addressed in a separate review.

Recommendation:

Despite a paucity of comparative data including long-term oncologic and functional data, TAMIS is a safe and effective means of local resection for benign and favorable early stage (T1) cancers following adequate workup for rectal lesions. It can be used as a conclusive biopsy for indeterminate T staged lesions in patients who are hesitant to undergo major resection with the intent to follow through with definitive treatment for T1 lesions exhibiting adverse pathologic features and T2 lesions. It may also be used as palliative resection for T3 cancers in patients medically unfit or unwilling to undergo an oncologic resection. A TAMIS resection can confirm complete pathologic response after neoadjuvant chemotherapy and radiation. The TAMIS platform is most advantageous for mid- and distal-rectal lesions that are unable to be removed colonoscopically, but should be used cautiously in the upper rectum, especially with full thickness resections. The TAMIS platform makes access for endoluminal surgery of the rectum straightforward, and expansion of its applications is expected to continue.

Quality of evidence: (+ +). GRADE recommendation: Weak

VI. Author financial disclosure/conflict of interest statement addendum

deBeche-Adams—consultant for Applied Medical, Hassan—no disclosures

VII. References

1. Guyatt G H, Oxman A D, Kunz R, Falck-Ytter Y, Vist G E, Liberati A, Schunemann H J (2008) Going from evidence to recommendations. BMJ 336:1049-1051

2. Guyatt G H, Oxman A D, Vist G E, Kunz R, Falck-Ytter Y, Alonso-Coello P, Schunemann H J (2008) GRADE: an emerging consensus on rating quality of evidence and strength of recommendations. BMJ 336:924-926

3. Buess G, Theiss R, Günther M, Hutterer F, Pichlmaier H. Transanal endoscopic microsurgery. Leber Magen Darm. 1985 Nov;15(6):271-9.

4. Buess G, Kipfmüller K, Hack D, Grüssner R, Heintz A, Junginger T. Technique of transanal endoscopic microsurgery. Surg Endosc. 1988;2(2):71-5.

5. Buess G, Mentges B, Manncke K, Starlinger M, Becker HD. Technique and results of transanal endoscopic microsurgery in early rectal cancer. Am J Surg. 1992 Jan;163(1):63-9; discussion 69-70.

6. Saclarides TJ, Smith L, Ko ST, Orkin B, Buess G. Transanal endoscopic microsurgery. Dis Colon Rectum. 1992 Dec;35(12):1183-91.

7. Lev-Chelouche D, Margel D, Goldman G, Rabau MJ. Transanal endoscopic microsurgery: experience with 75 rectal neoplasms. Dis Colon Rectum. 2000 May;43(5):662-7; discussion 667-8.

8. Cataldo PA. Transanal endoscopic microsurgery. Surg Clin North Am 2006; 86(4):915-2

9. de Graaf EJ, Burger JW, van Ijsseldijk AL, Tetteroo GW, Dawson I, Hop WC. Transanal endoscopic microsurgery is superior to transanal excision of rectal adenomas. Colorectal Dis. 2011 Jul;13(7):762-7. Epub 2010 Mar 23.

10. Moore JS, Cataldo PA, Osler T, Hyman NH. Transanal endoscopic microsurgery is more effective than traditional transanal excision for resection of rectal masses. Dis Colon Rectum. 2008 Jul;51(7):1026-30; discussion 1030-1. Epub 2008 May 15.

11. Maslekar S, Pillinger SH, Sharma A, Taylor A, Monson JR. Cost analysis of transanal endoscopic microsurgery for rectal tumours. Colorectal Dis. 2007 Mar;9(3):229-34.

12. Koebrugge B, Bosscha K, Ernst MF. Transanal endoscopic microsurgery for local excision of rectal lesions: is there a learning curve? Dig Surg. 2009;26(5):372-7. Epub 2009 Nov 13.

13. Christoforidis D, Cho HM, Dixon MR, Mellgren AF, Madoff RD, Finne CO. Transanal endoscopic microsurgery versus conventional transanal excision for patients with early rectal cancer. Ann Surg. 2009 May;249(5):776-82.

14. Atallah S, Albert M, Larach S. Transanal minimally invasive surgery: a giant leap forward. Surg Endosc. 2010 Sep;24(9):2200-5. Epub 2010 Feb 21.

15. Albert MR, Atallah SB, deBeche-Adams TC, Izfar S, Larach SW. Transanal minimally invasive surgery (TAMIS) for local excision of benign neoplasms and early-stage rectal cancer: efficacy and outcomes in the first 50 patients. Dis Colon Rectum. 2013 Mar;56(3):301-7.

16. Rimonda R, Arezzo A, Arolfo S, Salvai A, Morino M. TransAnal Minimally Invasive Surgery (TAMIS) with SILS™ port versus Transanal Endoscopic Microsurgery (TEM): a comparative experimental study. Surg Endosc. 2013 Oct;27(10):3762-8.

17. Lim SB, Seo SI, Lee JL, Kwak JY, Jang TY, Kim CW, Yoon YS, Yu CS, Kim JC. Feasibility of transanal minimally invasive surgery for mid-rectal lesions. Surg Endosc. 2012 Nov;26(11):3127-32. Epub 2012 Apr 28.

18. Barendse RM, Doornebosch PG, Bemelman WA, Fockens P, Dekker E, de Graaf EJ. Transanal employment of single access ports is feasible for rectal surgery. Ann Surg. 2012 Dec;256(6):1030-3.

19. Matz J, Matz A. Use of a SILS port in transanal endoscopic microsurgery in the setting of a community hospital. J Laparoendosc Adv Surg Tech A. 2012 Jan-Feb;22(1):93-6. Epub 2011 Dec 5.

20. Lorenz C, Nimmesgern T, Back M, Langwieler TE. Transanal single port microsurgery (TSPM) as a modified technique of transanal endoscopic microsurgery (TEM). Surg Innov. 2010 Jun;17(2):160-3.

21. Ragupathi M, Haas EM. Transanal endoscopic video-assisted excision: application of single-port access. JSLS. 2011 Jan-Mar;15(1):53-8.

22. Khoo RE. Transanal excision of a rectal adenoma using single-access laparoscopic port. Dis Colon Rectum. 2010 Jul;53(7):1078-9.

23. Smith RA, Anaya DA, Albo D, Artinyan A. A stepwise approach to transanal endoscopic microsurgery for rectal cancer using a single-incision laparoscopic port. Ann Surg Oncol. 2012 Sep;19(9):2859. Epub 2012 Apr 24.

24. Watts ES, Peacock O, Gupta A, Speake WJ, Lund JN. Anyone for TAMIS? Tech Coloproctol. 2013 Apr;17(2):253-5. Epub 2012 Feb 18.

25. Kennedy ML, Lubowski DZ, King DW. Transanal endoscopic microsurgery excision: is anorectal function compromised? Dis Colon Rectum. 2002 May;45(5):601-4.

26. Wang HS, Lin JK, Yang SH, Jiang JK, Chen WS, Lin TC. Prospective study of the functional results of transanal endoscopic microsurgery. Hepatogastroenterology. 2003 Sep-Oct;50(53):1376-80.

27. Lee TG1, Lee SJ. Transanal single-port microsurgery for rectal tumors: minimal invasive surgery under spinal anesthesia. Surg Endosc. 2014 Jan;28(1):271-80. Epub 2013 Sep 6.

28. Brown G. Staging rectal cancer: endoscopic ultrasound and pelvic MRI. Cancer Imaging. 2008; 8(Spec Iss A): S43–S45. Epub 2008 Oct 4.

29. Brown G. Imaging assessment of early rectal cancer. Recent Results Cancer Res. 2014;203:3-14.

30. National Comprehensive Cancer Network. Rectal Cancer (Version 3.2015). http://www.nccn.org.

31. Cataldo, PA (2011). Local Excision of Rectal Cancer In DE Beck et al. (eds.). The ASCRS Textbook of Colon and Rectal Surgery: Second Edition, pp 731-741.

32. Qi Y, Stoddard D, Monson JR. Indications and techniques of transanal endoscopic microsurgery (TEMS). J Gastrointest Surg. 2011 Aug;15(8):1306-8. Epub 2011 Jun 7.

33. Nascimbeni R, Burgart LJ, Nivatvongs S, Larson DR. Risk of lymph node metastasis in T1 carcinoma of the colon and rectum. Dis Colon Rectum. 2002 Feb;45(2):200-6.

34. Edge SB, Byrd DR, Compton CC, Fritz AG, Greene FL, Trotti A, editors. AJCC cancer staging manual (7th ed). New York, NY: Springer; 2010.

35. Heidary B, Phang TP, Raval MJ, Brown CJ. Transanal endoscopic microsurgery: a review. Can J Surg. 2014 April; 57(2): 127–138.

36. Kikuchi R, Takano M, Takagi K, et al. Management of early invasive colorectal cancer. Risk of recurrence and clinical guidelines. Dis Colon Rectum 1995;38:1286-95.

37. Choi PW, Yu CS, Jang SJ, et al. Risk factors for lymph node metastasis in submucosal invasive colorectal cancer. World J Surg 2008;32:2089-94.

38. Borschitz T, Heintz A, Junginger T. Transanal Endoscopic Microsurgical Excision of pT2 Rectal Cancer: Results and Possible Indications. Dis Colon Rectum. 2007 March;50(3):292-301.

39. Hahnloser D, Wolff B, Larson D, Ping J, Nivatvongs S. Immediate Radical Resection After Local Excision of Rectal Cancer: An Oncologic Compromise?. Dis Colon Rectum. 2005 March;48(3):429-437.

40. Baron PL, Enker WE, Zakowski ME, Urmacher C. Immediate vs. salvage resection after local treatment for early rectal cancer. Dis Colon Rectum. 1995;38:177–81.

41. Duek SD, Issa N, Hershko DD, Krausz MM. Outcome of transanal endoscopic microsurgery and adjuvant radiotherapy in patients with T2 rectal cancer. Dis Colon Rectum. 2008 Apr;51(4):379-84. Epub 2008 Jan 31.

42. Guerrieri M, Gesuita R, Ghiselli R, Lezoche G, Budassi A, Baldarelli M. Treatment of rectal cancer by transanal endoscopic microsurgery: experience with 425 patients. World J Gastroenterol. 2014 Jul 28;20(28):9556-63.

43. Lezoche E, Baldarelli M, Lezoche G, Paganini AM, Gesuita R, Guerrieri M. Randomized clinical trial of endoluminal locoregional resection versus laparoscopic total mesorectal excision for T2 rectal cancer after neoadjuvant therapy. Br J Surg. 2012 Sep;99(9):1211-8.

44. Lim SB, Seo SI, Lee JL, Kwak JY, Jang TY, Kim CW, Yoon YS, Yu CS, Kim JC. Feasibility of transanal minimally invasive surgery for mid-rectal lesions. Surg Endosc. 2012 Nov;26(11):3127-32. Epub 2012 Apr 28.

45. Smith FM, Waldron D, Winter DC. Rectum-conserving surgery in the era of chemoradiotherapy. Br J Surg. 2010 Dec;97(12):1752-64.

46. Habr-Gama A, Perez RO, Wynn G, Marks J, Kessler H, Gama-Rodrigues J. Complete clinical response after neoadjuvant chemoradiation therapy for distal rectal cancer: characterization of clinical and endoscopic findings for standardization. Dis Colon Rectum. 2010 Dec;53(12):1692-8.

47. Garcia-Aguilar J, Shi Q, Thomas CR Jr, Chan E, Cataldo P, Marcet J, Medich D, Pigazzi A, Oommen S, Posner MC. A phase II trial of neoadjuvant chemoradiation and local excision for T2N0 rectal cancer: preliminary results of the ACOSOG Z6041 trial. Ann Surg Oncol. 2012 Feb;19(2):384-91. Epub 2011 Jul 14.

48. Kundel Y, Brenner R, Purim O, Peled N, Idelevich E, Fenig E, Sulkes A, Brenner B. Is local excision after complete pathological response to neoadjuvant chemoradiation for rectal cancer an acceptable treatment option? Dis Colon Rectum. 2010 Dec;53(12):1624-31.

49. Kim CJ, Yeatman TJ, Coppola D, Trotti A, Williams B, Barthel JS, Dinwoodie W, Karl RC, Marcet J. Local excision of T2 and T3 rectal cancers after downstaging chemoradiation. Ann Surg. 2001 Sep;234(3):352-8; discussion 358-9.

50. Bedrosian I, Rodriguez-Bigas MA, Feig B, Hunt KK, Ellis L, Curley SA, Vauthey JN, Delclos M, Crane C, Janjan N, Skibber JM. Predicting the node-negative mesorectum after preoperative chemoradiation for locally advanced rectal carcinoma. J Gastrointest Surg. 2004 Jan;8(1):56-62; discussion 62-3.

51. Bujko K, Nowacki MP, Nasierowska-Guttmejer A, Kepka L, Winkler-Spytkowska B, Suwiński R, Oledzki J, Stryczyńska G, Wieczorek A, Serkies K, Rogowska D, Tokar P; Polish Colorectal Study Group. Prediction of mesorectal nodal metastases after chemoradiation for rectal cancer: results of a randomised trial: implication for subsequent local excision. Radiother Oncol. 2005 Sep;76(3):234-40.

52. Yeo SG, Kim DY, Kim TH, Chang HJ, Oh JH, Park W, Choi DH, Nam H, Kim JS, Cho MJ, Kim JH, Park JH, Kang MK, Koom WS, Kim JS, Nam TK, Chie EK, Kim JS, Lee KJ. Pathologic complete response of primary tumor following preoperative chemoradiotherapy for locally advanced rectal cancer: long-term outcomes and prognostic significance of pathologic nodal status (KROG 09-01). Ann Surg. 2010 Dec;252(6):998-1004.

53. Hahnloser D, Cantero R, Salgado G, Dindo D, Rega D, Delrio P. Transanal minimal invasive surgery for rectal lesions: should the defect be closed? Colorectal Dis. 2015 May;17(5):397-402.

54. McLemore EC, Weston LA, Coker AM, Jacobsen GR, Talamini MA, Horgan S, Ramamoorthy SL. Transanal minimally invasive surgery for benign and malignant rectal neoplasia. Am J Surg. 2014 Sep;208(3):372-81.

55. Maglio R, Muzi GM, Massimo MM, Masoni L. Transanal minimally invasive surgery (TAMIS): new treatment for early rectal cancer and large rectal polyps—experience of an Italian center. Am Surg. 2015 Mar;81(3):273-7.

56. Albert MR, Atallah SB, deBeche-Adams TC, Izfar S, Larach SW. Transanal minimally invasive surgery (TAMIS) for local excision of benign neoplasms and early-stage rectal cancer: efficacy and outcomes in the first 50 patients. Dis Colon Rectum. 2013 Mar;56(3):301-7.

57. Bislenghi G, Wolthuis AM, de Buck van Overstraeten A, D'Hoore A. AirSeal system insufflator to maintain a stable pneumorectum during TAMIS. Tech Coloproctol. 2015 Jan;19(1):43-5. Epub 2014 Nov 26.

58. Guerrieri M, Baldarelli M, Organetti L, Grillo Ruggeri F, Mantello G, Bartolacci S, Lezoche E. Transanal endoscopic microsurgery for the treatment of selected patients with distal rectal cancer: 15 years experience. Surg Endosc. 2008 Sep;22(9):2030-5. Epub 2008 Jun 14.

59. Marks JH, Valsdottir EB, DeNittis A, Yarandi SS, Newman DA, Nweze I, Mohiuddin M, Marks GJ. Transanal endoscopic microsurgery for the treatment of rectal cancer: comparison of wound complication rates with and without neoadjuvant radiation therapy. Surg Endosc. 2009 May;23(5):1081-7. Epub 2009 Mar 5.

60. Silveira Mendes CR, Miranda Ferreira LS, Aguiar Sapucaia R, Andrade Lima M, Alonso Araujo SE Transanal minimally-invasive surgery (TAMIS): technique and results from an initial experience. J Coloproctol. 2013;33(4):191–195.

61. van den Boezem PB, Kruyt PM, Stommel MW, Tobon Morales R, Cuesta MA, Sietses C. Transanal single-port surgery for the resection of large polyps. Dig Surg. 2011;28:412–416.

62. Martin-Perez B, Andrade-Ribeiro GD, Hunter L, Atallah S. A systematic review of transanal minimally invasive surgery (TAMIS) from 2010 to 2013. Tech Coloproctol. 2014 Sep;18(9):775-88. Epub 2014 May 7.

63. Bridoux V, Schwarz L, Suaud L, Dazza M, Michot F, Tuech JJ. Transanal minimal invasive surgery with the EndorecTM trocar: a low cost but effective technique. Int J Colorectal Dis. 2014;29:177–181.

64. Hompes R, Ris F, Cunningham C, Mortensen NJ, Cahill RA. Transanal glove port is a safe and cost-effective alternative for transanal endoscopic microsurgery. Br J Surg. 2012;99:1429–1435.

65. Atallah S, Albert M, Debeche-Adams T, Larach S. Transanal minimally invasive surgery (TAMIS): applications beyond local excision. Tech Coloproctol. 2013 Apr;17(2):239-43.

66. Zhang H1, Zhang YS, Jin XW, Li MZ, Fan JS, Yang ZH. Transanal single-port laparoscopic total mesorectal excision in the treatment of rectal cancer. Tech Coloproctol. 2013 Feb;17(1):117-23. Epub 2012 Aug 31.

67. Atallah S, Martin-Perez B, Albert M, deBeche-Adams T, Nassif G, Hunter L, Larach S. Transanal minimally invasive surgery for total mesorectal excision (TAMIS-TME): results and experience with the first 20 patients undergoing curative-intent rectal cancer surgery at a single institution. Tech Coloproctol. 2014 May;18(5):473-80. Epub 2013 Nov 23.

68. Karakayali FY, Tezcaner T, Moray G. Anorectal function and outcomes after transanal minimally invasive surgery for rectal tumors. J Minim Access Surg. 2015 Oct-Dec;11(4):257-62.

69. Verseveld M, Barendse RM, Gosselink MP, Verhoef C, de Graaf EJ, Doornebosch PG. Transanal minimally invasive surgery: impact on quality of life and functional outcome. Surg Endosc. 2016 Mar;30(3):1184-7. Epub 2015 Jul 3.

70. Hahnloser D, Cantero R, Salgado G, Dindo D, Rega D, Delrio P. Transanal minimal invasive surgery for rectal lesions: should the defect be closed? Colorectal Dis. 2015 May;17(5):397-402.

71. Mentges B, Buess G, Raestrup H, et al. TEM results of the Tuebingen group. Endosc Surg Allied Technol 1994;2:247-50.

72.Kinoshita T, Kanehira E, Omura K, et al. Transanal endoscopic microsurgery in the treatment of rectal carcinoid tumor. Surg Endosc 2007;21:970-4.

73.Araki Y, Isomoto H, Shirouzu K. Clinical efficacy of video-assisted gasless transanal endoscopic microsurgery (TEM) for rectal carcinoid tumor. Surg Endosc 2001;15:402-4.

74. Ishikawa K, Arita T, Shimoda K, et al. Usefulness of transanal endo- scopic surgery for carcinoid tumor in the upper and middle rectum. Surg Endosc 2005;19:1151-4.

75.Nakagoe T, Ishikawa H, Sawai T, et al. Gasless, video endoscopic transanal excision for carcinoid and laterally spreading tumors of the rectum. Surg Endosc 2003;17:1298-304.

76.Kobayashi K, Katsumata T, Yoshizawa S, et al. Indications of endo- scopic polypectomy for rectal carcinoid tumors and clinical usefulness of endoscopic ultrasonography. Dis Colon Rectum 2005;48:285-91.

77. Keller DS, Tahilramani RN, Flores-Gonzalez JR, Mahmood A, Haas EM. Transanal Minimally Invasive Surgery: Review of Indications and Outcomes from 75 Consecutive Patients. J Am Coll Surg. 2016 May;222(5):814-22.

78. Baatrup G, Borschitz T, Cunningham C, Qvist N. Perforation into the peritoneal cavity during transanal endoscopic microsurgery for rectal cancer is not associated with major complications or oncological compromise. Surg Endosc. 2009 Dec;23(12):2680-3.

79. Gavagan JA, Whiteford MH, Swanstrom LL. Full-thickness intraperitoneal excision by transanal endoscopic microsurgery does not increase short-term complications. Am J Surg. 2004 May;187(5):630-4.

80. Kumar AS, Sidani SM, Kolli K, Stahl TJ, Ayscue JM, Fitzgerald JF, Smith LE. Transanal endoscopic microsurgery for rectal carcinoids: the largest reported United States experience. Colorectal Dis. 2012 May;14(5):562-6.

81. Molina G, Bordeianou L, Shellito P, Sylla P. Transanal endoscopic resection with peritoneal entry: a word of caution. Surg Endosc. 2016 May;30(5):1816-25.